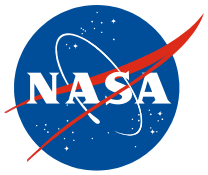


National Aeronautics and
Space Administration

Office of Earth Science

Sample of Sensors & Missions for NASA Public Health Applications

Prepared for
NASA Earth Science Enterprise
Application Division
Public Health Applications Program

Prepared by
NASA Public Health Applications Team
Stennis Space Center, MS

Version 4
December 2003

Table of Contents

Background

NASA MISSION

NASA's mission is to understand and protect our home planet, to explore the universe and search for life, to inspire the next generation of explorers…as only NASA can.

The mission of NASA's Earth Science Enterprise (ESE) is to develop a scientific understanding of the Earth system and its response to natural and human-induced changes to enable improved predictions of climate, weather, and natural hazards.

NASA's unique technical capability to pursue science through space-based observation allows researchers to observe the Earth on a global scale – as an integrated system. NASA scientists use remote sensing technology as a tool to acquire detailed information about the Earth.

WHAT IS REMOTE SENSING?

Remote sensing involves a ***sensor***, which gathers observational data about an object or phenomenon, without direct physical contact between that sensor and the object or phenomenon being observed. Remote sensing often refers to the collection of data using sensors that are integrated into a particular platform.

Platforms are the structures that house the remote sensor(s). A platform can be orbital (e.g., satellites), suborbital (e.g., airplanes), or *in-situ* (e.g., ground weather station networks).

WHAT ARE THE DIFFERENT TYPES OF REMOTE SENSORS?

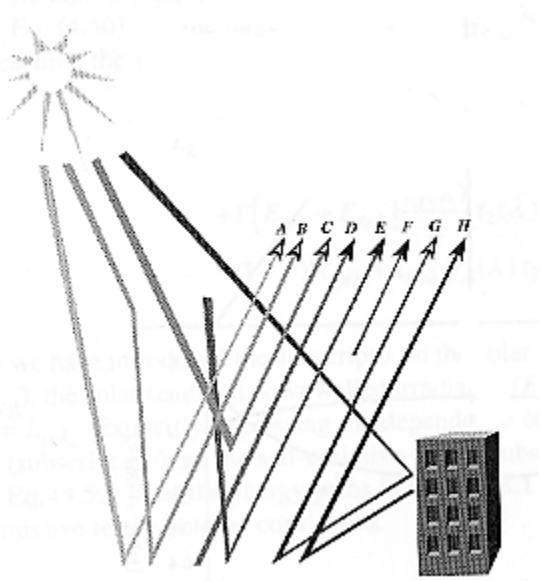
For a sensor to function, there must be an energy source. That source can be either active or passive.

Active sensors emit electro-magnetic energy in order to sense their target. Examples of active sensors include sonar, radar, and lidar.

Passive sensors require electromagnetic energy to be emitted or reflected by the object being sensed. An example of a passive sensor is NASA and USGS Landsat 7.

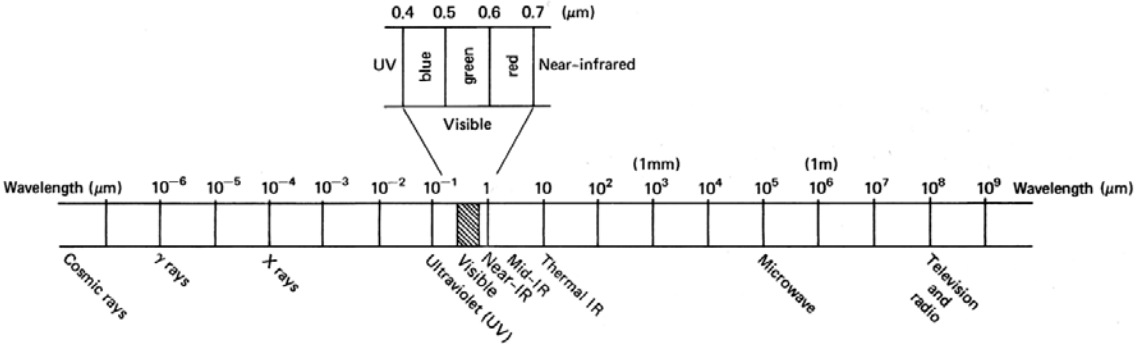
WHAT ARE DATA PRODUCTS?

Data products are generated from remotely sensed data that is collected from sensors. The products can be quantitative and/or qualitative; can be produced at different spatial, temporal, and radiometric resolutions; and can be processed at different levels of sophistication. Data products can be supplied in a wide variety of media and formats (e.g., CD-ROMs, 8mm tapes, maps, paper prints, etc.), and they can be applied to research projects and decision support systems.



(Schott, 1997)

Solar energy paths and self-emitted thermal energy paths associated with the photon flux onto the sensor.
A) adjacency
B) skylight
C) upwelled radiance
D) self-emitted radiance
E) downwelled radiance
F) atmospheric upwelled radiance
G) multi-reflected radiance
H) background object radiance



(Lillesand and Kiefer, 2000)

The electromagnetic spectrum.

I. Current Orbital Sensors

I.1 AIRS (Atmospheric Infrared Sounder)
I.2 AMSR (Advanced Microwave Scanning Radiometer)
I.3 ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer)
I.4 AVHRR/3 (Advanced Very High Resolution Radiometer)
I.5 ETM+ (Enhanced Thematic Mapper Plus)
I.6 HSB (Humidity Sounder for Brazil)
I.7 MODIS (Moderate Resolution Imaging Spectroradiometer)
I.8 MWR (Microwave Radiometer)
I.9 PR (Precipitation Radar)
I.10 TOMS (Total Ozone Mapping Spectrometer)
I.11 VGT 1 & 2 (VEGETATION Monitoring Instrument)

I.1

AIRS

(Atmospheric Infrared Sounder)

AIRS is an advanced infrared sounder designed for providing more accurate atmosphere, land, and oceans data. Important parameters derived from AIRS observations are atmospheric temperature and humidity profiles, as well as ocean and land surface temperatures.

PRODUCT SUMMARY:

- 3-D measurements of atmospheric temperature, pressure, clouds, sea surface temperature, and greenhouse gases in the Earth's atmosphere

VITAL FACTS:

- Type: Active sensor
- Instrument: Grating multispectral atmospheric IR sounder
- Bands: 2,378 from 3.7-15.4 μm; visible/NIR channels from 0.4-1 μm
- Horizontal Resolution: 13.5 km IR, 2.3 km visible/NIR
- Vertical Coverage (by pressure): Surface to 0.016 mb
- Swath: 1,650 km
- Repeat Time: 2 days
- Design Life: 5 years

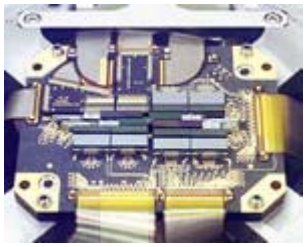
MISSION:

Aqua – May 2002 http://aqua.nasa.gov

OWNER:

- U.S., NASA

http://aqua.nasa.gov/AIRS3.html



I.2

AMSR

(Advanced Microwave Scanning Radiometer)

AMSR is a microwave radiometer that measures microwave radiation from the Earth's surface and atmosphere. Important measurements collected by AMSR are total water vapor content, total liquid water content, precipitation, snow water equivalent, soil moisture, sea surface temperature, sea surface wind speed, and sea ice extent.

PRODUCT SUMMARY:

- Atmospheric and weather monitoring

VITAL FACTS:

- Type: Passive sensor
- Instrument: Passive microwave radiometer
- Bands: Six (AMSR-E) and eight (AMSR) from 6-89 GHz
- Spatial Resolution: From ~5 km at 89 GHz to ~50 km at 6 GHz
- Swath: 1,445 km (AMSR-E), 1,600 km (AMSR)
- Repeat Time: 4 days
- Design Life: 3 years

MISSION:

- Aqua – May 2002 (AMSR-E) http://aqua.nasa.gov
- ADEOS II – December 2002 (AMSR) http://www.nasda.go.jp/projects/sat/adeos2/index_e.html

OWNER:

- Japan, NASDA

http://wwwghcc.msfc.nasa.gov/AMSR/
http://aqua.nasa.gov/AMSRE3.html

I.3

ASTER

(Advanced Spaceborne Thermal Emission and Reflection Radiometer)

ASTER is a multispectral sensor that combines a wide spectral coverage and high spatial resolution in the visible/near-infrared (VNIR) through short-wave infrared (SWIR) to the thermal infrared (TIR) regions. ASTER collects data on vegetation and ecosystem dynamics, geology and soils, land surface climatology, hydrology, and land cover change.

PRODUCT SUMMARY:

- Detailed maps of land surface temperature, emissivity, reflectance, and elevation to better understand the interactions between the biosphere, hydrosphere, lithosphere, and atmosphere

VITAL FACTS:

- Type: Passive sensor
- Four subinstruments:
  - VNIR: one nadir-looking and one rear-looking pushbroom (along-track) radiometer
  - SWIR: one pushbroom (along-track) radiometer
  - TIR: one whiskbroom (cross-track) radiometer
- Bands: 14 between 0.52 µm and 12.0 µm
- Spatial Resolution: VNIR - 15 m, SWIR - 30 m, TIR - 90 m
- Swath: 60 km at nadir
- Repeat Time: Between 4 and 16 days
- Design Life: 5 years

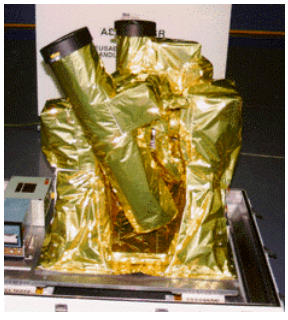
MISSION:

- Terra – December 1999 http://terra.nasa.gov

OWNER:

- Japan, METI
- U.S., NASA

http://asterweb.jpl.nasa.gov/



I.4 AVHRR/3

(Advanced Very High Resolution Radiometer, Version 3)

The AVHRR/3 is a broadband, six-channel imaging radiometer that detects energy in the visible (VIS), near infrared (NIR), and thermal infrared (TIR) portions of the electromagnetic spectrum. AVHRR/3 collects data on sea surface temperatures, atmospheric aerosols over the oceans, vegetative index, and cloud patterns.

PRODUCT SUMMARY:

- Measurements of reflected solar energy (visible and NIR) and radiated thermal energy from land, sea, clouds, and the intervening atmosphere

VITAL FACTS:

- Type: Passive sensor
- Instrument: Cross-track (whiskbroom) scanning radiometer
- Bands: Six from 0.58 and 12.5 µm
- Spatial Resolution: 0.5 km (VIS), 1 km (IR)
- Swath: 2,940 km
- Repeat Time: 1 day
- Design Life: 3 to 5 years

MISSIONS:

- POES (Polar Orbiting Environmental Satellites) – May 1998, September 2000, June 2002 http://poes.gsfc.nasa.gov

OWNER:

- U.S., NOAA

http://www2.ncdc.noaa.gov/docs/klm/index.htm

I.5 ETM+
(Enhanced Thematic Mapper Plus)

The ETM+ is an eight-band, multispectral scanning radiometer capable of providing high-resolution imaging of the Earth's surface. ETM+ detects spectrally filtered radiation at short wave, visible, near, middle, and thermal frequency bands. This sensor was designed to acquire data about the Earth on a systematic, repetitive basis.

PRODUCT SUMMARY:
- Measures surface radiance and emittance, land cover state and change, and vegetation type

VITAL FACTS:
- Type: Passive sensor
- Instrument: Whiskbroom (cross-track) multispectral scanning radiometer
- Bands:
  - Bands one to five: 0.45-0.52 µm, 0.52-0.61 µm, 0.63-0.69 µm, 0.75-0.90 µm, 1.55-1.75 µm
  - Band six: 10.40-12.5 µm
  - Band seven: 2.09-2.35 µm
  - Panchromatic: 0.52-0.90 µm
- Spatial Resolution:
  - Bands one to five, band seven: 30 m
  - Band six: 60 m
  - Panchromatic: 15 m
- Swath: 185 km
- Repeat Time: 16 days
- Design Life: 5 years

MISSION:
- Landsat 7 – April 1999 http://landsat7.usgs.gov/

OWNER:
- U.S., NASA

http://ls7pm3.gsfc.nasa.gov/Science.html

I.6 HSB
(Humidity Sounder for Brazil)

HSB is a four-channel, microwave moisture sounder that provides supplementary water vapor and liquid data for AIRS infrared measurements. HSB obtains profiles of atmospheric humidity and detects precipitation under clouds with 15 km (nadir) resolution to correct infrared measurements for the effects of clouds and to determine global humidity.

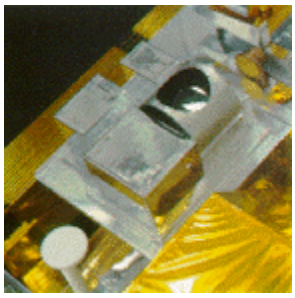
PRODUCT SUMMARY:
- Records humidity profiles throughout the atmosphere

VITAL FACTS:
- Type: Passive sensor
- Instrument: Passive microwave radiometer
- Frequency: 150 GHz and 183 GHz
- Horizontal Resolution: 13.5 km
- Swath: 1,650 km
- Repeat Time: 2 days
- Design Life: 6 years

MISSION:
- Aqua – May 2002 http://aqua.nasa.gov

OWNER:
- Brazil, INPE (Instituto Nacional De Pesquisas Espaciais)

http://aqua.nasa.gov/HSB3.html



I.7 MODIS

(Moderate Resolution Imaging Spectroradiometer)

MODIS has a unique combination of detection features: a wide spectral range of electromagnetic energy (in 36 spectral bands), 3 different spatial resolution measurements, and data acquisition over the entire Earth every 1 to 2 days. MODIS collects data on land/cloud/aerosol properties/boundaries, ocean color, atmospheric water vapor, surface cloud temperature, atmospheric temperature, cirrus cloud, cloud properties, water vapor, ozone, surface/cloud temperature, and cloud top altitude.

PRODUCT SUMMARY:

- Congruent measurements in 36 spectral bands for observations of high-priority global dynamics and processes occurring on the land, in the oceans, and in the lower atmosphere

VITAL FACTS:

- Type: Passive sensor
- Instrument: Whiskbroom (cross-track) imaging radiometer
- Bands: 36 bands ranging from 0.4 to 14.5 µm
- Spatial Resolution: 250 m, 500 m, and 1,000 m
- Swath: 2,330 km (cross-track) by 10 km (along-track at nadir)
- Repeat Time: Global coverage in 1-2 days
- Design Life: 6 years

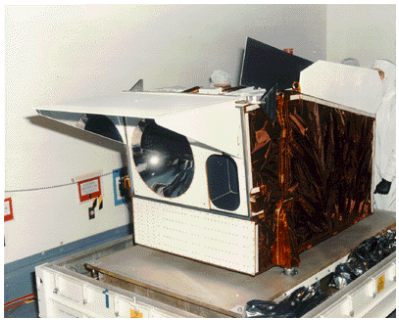
MISSIONS:

- Terra – December 1999 http://terra.nasa.gov
- Aqua – May 2002 http://aqua.nasa.gov

OWNER:

- U.S., NASA

http://modis.gsfc.nasa.gov/



I.8 MWR
(Microwave Radiometer)

The MWR is a sensitive microwave receiver that provides time-series measurements of vapor and liquid water. It is tuned to measure the microwave emissions, at specific frequencies, of the vapor and liquid water molecules in the atmosphere. MWR data are useful for the determination of surface emissivity and soil moisture, for atmospheric studies, and for ice characterization.

PRODUCT SUMMARY:
- Measurements of tropospheric water vapor/liquid content

VITAL FACTS:
- Type: Passive sensor
- Instrument: Dual-channel, nadir-pointing, Dicke-type radiometer
- Frequency: 23.8 and 36.5 GHz
- Resolution: 20 km
- Swath: 20 km
- Repeat Time: 35 days
- Design Life: 4 years

MISSION:
- ENVISAT – March 2002 http://envisat.esa.int/

OWNER:
- Europe, ESA

http://www.esoc.esa.de/external/mso/envisat.html

I.9 PR
(Precipitation Radar)

PR is an active, phased-array radar designed to collect data on 3-dimensional rainfall structure and to achieve quantitative rainfall measurements over land and oceans. The PR also provides rain structure information, including the intensity and distribution of rain, rain type, storm depth, and the height at which snow melts into rain.

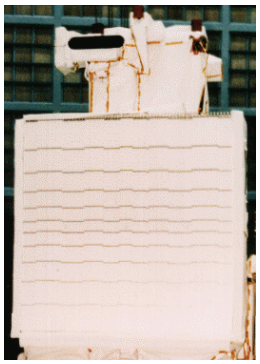
PRODUCT SUMMARY:
- 3-D rainfall distribution over land and oceans

VITAL FACTS:
- Type: Active sensor
- Instrument: L-band radar
- Channels: 13.796 and 13.802 GHz
- Horizontal Resolution (nadir): 4.3 km
- Vertical Resolution (nadir): 0.25 km
- Vertical Coverage: Surface to 15 km
- Swath: 220 km
- Repeat Time: TBD
- Design Life: 4 years

MISSION:
- TRMM (Tropical Rainfall Measuring Mission) – November 1997
  http://trmm.gsfc.nasa.gov

OWNER:
- U.S., NASA

http://trmm.gsfc.nasa.gov/overview_dir/pr.html



I.10 TOMS
(Total Ozone Mapping Spectrometer)

TOMS is an atmospheric sensor that measures the albedo of the Earth's atmosphere at six narrow spectral bands in the near-ultraviolet region. It was designed to collect data on the global ozone content, to observe sulfur dioxide resulting from volcanic eruptions, and to observe environmentally important areas.

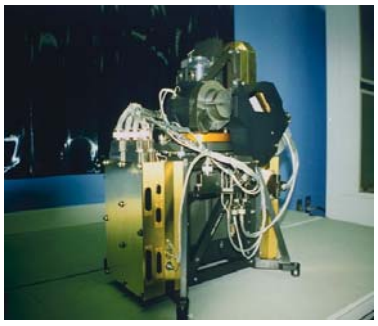
PRODUCT SUMMARY:
- Measurements of total column ozone, aerosol index, solar irradiance reflectivity, erythemal UV exposure, and sulfur dioxide atmospheric concentrations

VITAL FACTS:
- Type: Passive sensor
- Instrument: Backscatter UV spectrometer
- Bands: Six at .3086-.360 µm
- Horizontal Resolution: 3 degrees IFOV, 38 km at nadir
- Vertical Resolution: ~5 km
- Vertical Coverage: 0-~58 km
- Swath: ~2,200 km
- Repeat Time: Daily global coverage
- Design Life: 2 years

MISSIONS:
- NIMBUS 7 – October 1978 to May 1993 http://www.earth.nasa.gov/history/nimbus/nimbus7.html
- Meteor 3M/N2 – August 1991 to December 1994 http://www-sage3.larc.nasa.gov/
- ADEOS – August 1996 to June 1997 http://www.nasda.go.jp/projects/sat/adeos/index_e.html
- Earth Probe – July 1996 to present http://toms.gsfc.nasa.gov
- DSCOVR – TBD http://triana.gsfc.nasa.gov/home/

OWNER:
- U.S., NASA

http://toms.gsfc.nasa.gov/



I.11 VGT 1 & 2
(VEGETATION Monitoring Instrument)

The VEGETATION Monitoring Instrument acquires medium-resolution imagery in four spectral bands: blue, which enables atmospheric corrections; red and NIR, which are sensitive to the vegetation's photosynthetic activity and cell structure; and SWIR, which is sensitive to soil and vegetation moisture content.

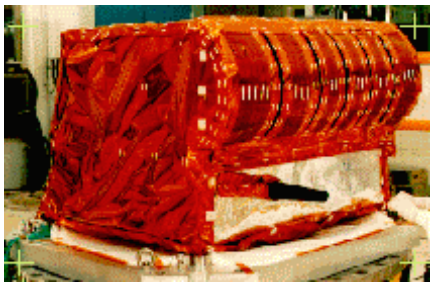
PRODUCT SUMMARY:
- Monitoring of vegetation cover and soil moisture content to forecast crop yields

VITAL FACTS:
- Type: Passive sensor
- Instrument: Wide field-of-view radiometric imaging sensor
- Bands: blue, red, NIR, SWIR
- Spatial Resolution: 1 km
- Swath: 2,250 km
- Repeat Time: 1 day
- Design Life: 5 years

MISSIONS:
- SPOT 4 (Satellite Probatoire d'Observation de la Terre – 4) – March 1998
- SPOT 5 (Satellite Probatoire d'Observation de la Terre – 5) – May 2002
  http://www.spotimage.fr/home/

OWNERS:
- France, Centre National d'Etudes Spatiales (CNES)
- Swedish National Space Board (SNSB)
- Agencia Spatiale Italiana (ASI)
- Belgium Office for Scientific, Technical and Cultural Affairs (OSTC)

http://www.spot-vegetation.com/



II. Future Orbital Sensors

II.1 GIFTS (Geosynchronous Imaging Fourier Transform Spectrometer)
II.2 GPSOS (Global Positioning System Occultation Sensor)
II.3 HYDROS Radar/Microwave Radiometer
II.4 MHS (Microwave Humidity Sounder)
II.5 MIRAS (Microwave Imaging Radiometer using Aperture Synthesis)

II.1 GIFTS

(Geosynchronous Imaging Fourier Transform Spectrometer)

GIFTS will use large area format focal plane (LFPA) infrared detector arrays in a Fourier Transform spectrometer (FTS) to collect high spectral resolution and high spatial resolution infrared radiance spectra over a large geographic area. GIFTS will combine advanced technologies to observe surface thermal properties and atmospheric weather and chemistry variables in four dimensions. The primary measurement objective of GIFTS is to profile atmospheric wind velocity. Temperature, humidity, and wind velocity parameters will be measured in near real time.

PRODUCT SUMMARY:

- Atmospheric data measurements of temperature, wind patterns, cloud cover, humidity, and pollutants in both the Earth's troposphere and stratosphere

VITAL FACTS:

- Type: Passive sensor
- Instrument: Geosynchronous imaging Fourier transform spectrometer
- Bands (two): Visible and SWIR with tunable wavelength
- Horizontal Resolution: ~4 km
- Vertical Resolution: 1-2 km
- Vertical Coverage (by pressure): Surface to 20 mb
- Swath: 6,000-10,000 km (full disk Earth)
- Repeat Time: TBD
- Design Life: TBD

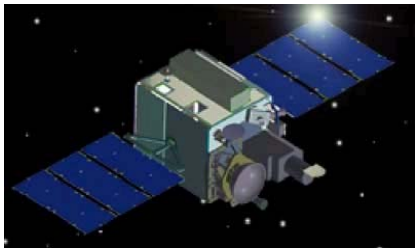
MISSION:

- EO3 – GIFTS (Earth Observation-3 - Geosynchronous Imaging Fourier Transform Spectrometer) – 2005-2006 http://nmp.jpl.nasa.gov/eo3/about/about.html

OWNERS:

- U.S., NASA
- U.S., NOAA

http://its.ssec.wisc.edu/~bormin/GIFTS/
http://nmp.jpl.nasa.gov/eo3/tech/gifts.html



II.2 GPSOS

(Global Positioning System Occultation Sensor)

GPSOS will be used as an operational and scientific instrument for atmospheric sounding by radio occultation techniques, providing information regarding electron density profiles and ionospheric scintillation for improved understanding of the atmosphere. It will provide secondary measurements for tropospheric temperature and humidity profiles. An advanced GPSOS will monitor signals received from the constellation of 24 GPS satellites that circle the Earth. By measuring the signal variations from these satellites as they rise and set through the atmosphere, scientists will be able to characterize atmospheric pressure, temperature, and humidity profiles with greater accuracy.

PRODUCT SUMMARY:

- Global scale monitoring of ionospheric electron density profiles and scintillation properties

VITAL FACTS:

- Type: Passive sensor
- Instrument: GPS L1 and L2 bands
- Vertical Range: Surface to >150 km
- Repeat Cycle: <20 days
- Design life: 5 years

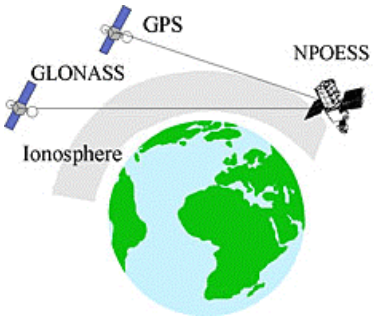
MISSION:

- NPOESS – 2009 http://www.ipo.noaa.gov/index2.html

OWNER:

- U.S., NOAA

http://npoess.noaa.gov/Technology/gpsos_summary.html



II.3 HYDROS Radar/Microwave Radiometer
(Hydrospheric States)

HYDROS is an L-band (1400-1427 MHz) radar/radiometer designed for high-resolution mapping of surface soil moisture and of landscape freeze/thaw dynamics.

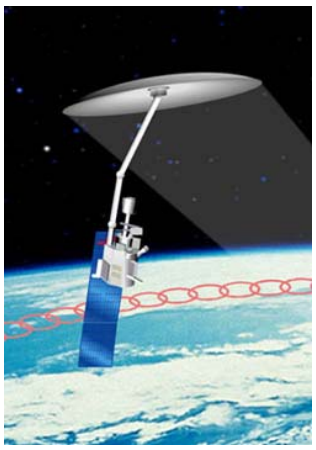
PRODUCT SUMMARY:
- Soil moisture and freeze/thaw maps

VITAL FACTS:
- Type: Active or passive sensor
- Instrument: L-band radar/microwave radiometer
- Swath: 1,000 km
- Temporal Sampling: Global 2-3 days
- Spatial Resolution:
  - Hydro-climatology soil moisture: 40 km
  - Hydro-meteorology soil moisture: 10 km
  - Freeze/thaw condition: 3 km
- Repeat Time: TBD
- Design Life: 2 years

MISSION:
- HYDROS – June 2006 http://essp.gsfc.nasa.gov/hydros/

OWNER:
- U.S., NASA

http://essp.gsfc.nasa.gov/hydros/



II.4 MHS
(Microwave Humidity Sounder)

MHS is a five-channel microwave instrument that measures profiles of atmospheric humidity. It is designed to complement satellite instruments measuring atmospheric temperatures. MHS will also be sensitive to liquid water in clouds and will provide qualitative estimates of precipitation rate.

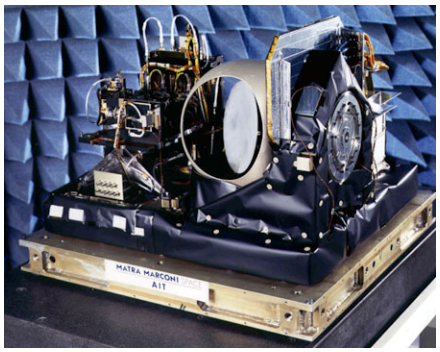
PRODUCT SUMMARY:
- Designed for the measurement of atmospheric humidity

VITAL FACTS:
- Type: Passive sensor
- Instrument: Cross-track (whiskbroom) scanning microwave radiometer
- Channels (five): 89, 157, 183±1, 183±3, and 190 GHz
- Horizontal Resolution: 15 km
- Swath: 2,150 km
- Repeat Time: 29 days
- Design Life: 2 years

MISSIONS:
- NOAA-N POES (National Oceanic and Atmospheric Administration-N Polar orbiting Operational Environmental Satellite) – 2004
- NOAA-N1 POES (National Oceanic and Atmospheric Administration-N1 Polar orbiting Operational Environmental Satellite) – 2008
  http://podaac.jpl.nasa.gov:2031/SOURCE_DOCS/noaa-n.html
- MetOp (Meteorological Operations) – 2005
  http://www.esa.int/export/esaME/index.html

OWNERS:
- U.S., NOAA
- EU, EUMETSAT

http://discovery.osd.noaa.gov/ijps/payloads.htm



II.5 MIRAS

(Microwave Imaging Radiometer using Aperture Synthesis)

MIRAS is a passive L-band (1400-1427 MHz) two-dimensional interferometer capable of recording the horizontal and vertical polarization (optional polarimetric observations possible) of the brightness temperature at several incident angles (0-55 degrees).

PRODUCT SUMMARY:

- Measurement of soil moisture and ocean salinity at a global scale

VITAL FACTS:

- Type: Passive sensor
- Instrument: L-band two-dimensional interferometer
- Frequency: 1.43 MHz
- Spatial Resolution: 50 km
- Swath: 1,000 km
- Repeat Time: 3 days or 1 month
- Design Life: 3 years

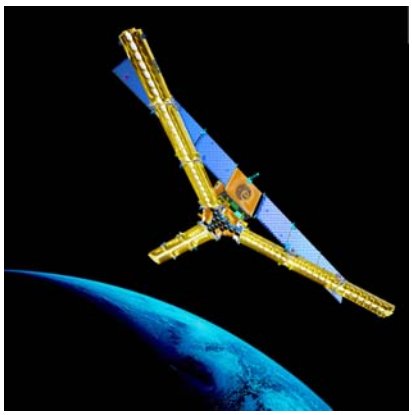
MISSION:

- SMOS – 2007 http://www.esa.int/export/esaLP/smos.html

OWNER:

- Europe, ESA (European Space Agency)

http://www.esa.int/est/prod/prod0662.htm



III. Current Suborbital Sensors

III.1 AIRSAR

(Airborne Synthetic Aperture Radar)

AIRSAR is a side-looking radar instrument that collects fully polarimetric data (POLSAR) at three radar wavelengths: C-band, L-band, and P-band. AIRSAR can also collect two types of interferometric data: cross-track (whiskbroom) interferometric data (TOPSAR) that are sensitive to topography, and along-track (pushbroom) interferometric (ATI) data that can be used to measure ocean surface currents. AIRSAR is an all-weather imaging instrument that is able to penetrate clouds and collect data at night. AIRSAR's longer wavelengths allow it to penetrate into the forest canopy and, in extremely dry areas, through thin sand cover and dry snow pack.

PRODUCT SUMMARY:

- Land classification, topographic mapping, and measuring current movement

VITAL FACTS:

- Type: Active sensor
- Instrument: SAR
- Platform: NASA DC-8 aircraft
- Wavelengths: P-band (0.45 GHz), L-band (1.26 GHz), C-band (5.31 GHz)
- Range Resolution: P-band (7.5 m), L-band (3.75 m), C-band (1.875 m)
- Swath: 10 km

MISSIONS:

- Various Earth science projects

OWNER:

- U.S., NASA

http://airsar.jpl.nasa.gov/

III.2 AVIRIS

(Airborne Visible/Infrared Imaging Spectrometer)

AVIRIS is an optical sensor that delivers calibrated images in 224 contiguous spectral channels (bands). AVIRIS uses a scanning mirror to sweep back and forth (whiskbroom), producing pixels for the 224 detectors. The main objective of AVIRIS is to identify, measure, and monitor constituents of the Earth's surface and atmosphere based on molecular absorption and particle scattering signatures.

PRODUCT SUMMARY:

- Measurements of transmitted, reflected, and scattered solar energy from Earth's surface and atmosphere used to characterize ecological, oceanographic, geological, and other environmental phenomena

VITAL FACTS:

- Type: Passive sensor
- Instrument: Hyperspectral whiskbroom (cross-track) imaging spectrometer
- Platform: NASA ER-2 and Twin Otter Turboprop
- Bands: 224 channels from 0.38 to 2.50 µm
- Spatial Resolution: 20 m at 20 km altitude (ER-2); 4 m at 4 km altitude (Twin Otter Turboprop)
- Swath: 11 km at 20 km altitude (ER-2); 2 km at 4 km altitude (Twin Otter Turboprop)

MISSIONS:

- Various Earth science projects

OWNER:

- U.S., NASA

http://popo.jpl.nasa.gov/html/aviris.overview.html

III.3 CRIS

(Coastal Research Imaging Spectrometer)

CRIS is a pushbroom (along-track) remote sensing imaging system that collects both visible hyperspectral and thermal infrared radiance imaging data. CRIS is intended to support precise imaging spectroscopic studies of water bodies by using precise temperature measurements of the water surface and correlating them to water biotic, sediment, or nutrient loads.

PRODUCT SUMMARY:

- Ocean color, vegetation spectra, and investigation of non-point-source pollution

VITAL FACTS:

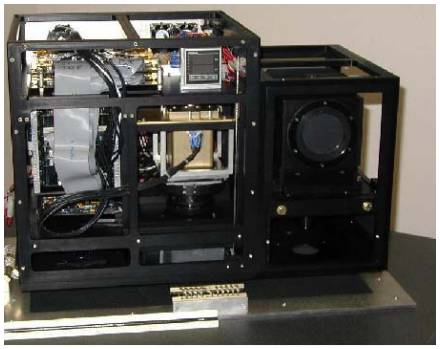
- Type: Passive sensor
- Instrument: Hyperspectral +1 Broadband Thermal Pushbroom
- Platform: Cessna twin engine and others
- Bands: 256
- Wavelength: 400-800 nm, 8-10 µm
- Horizontal Resolution: 0.25 mrad
- IFOV: 0.55 mrad

MISSIONS:

- Various Earth science missions

OWNER:

- U.S., NASA



III.4 MASTER

(MODIS/ASTER Airborne Simulator)

MASTER is a scanning spectrometer that operates in 50 spectral bands ranging from visible to thermal infrared regions. MASTER was developed for the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) and Moderate Resolution Imaging Spectroradiometer (MODIS) satellite instruments to support algorithm development, calibration, and validation. MASTER is intended primarily to study geologic and Earth surface properties.

PRODUCT SUMMARY:

- Measurements of land surface, ice, water, cloud and sea/land surface temperature, emissivity, reflectance, and elevation to support MODIS and ASTER algorithm development, calibration, and validation

VITAL FACTS:

- Type: Passive sensor
- Instrument: Suborbital scanning spectrometer
- Platform: NASA ER-2, DC-8 aircraft
- Bands: 50 from 0.4-13.0 µm
- Spatial Resolution: 5-30 m (depending on platform)
- Swath: 3.5-14 km

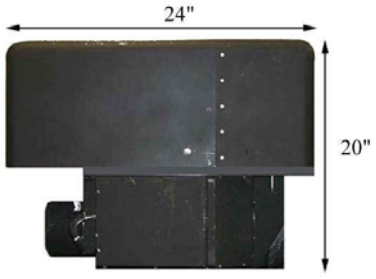
MISSIONS:

- Various Earth science projects

OWNER:

- U.S., NASA

http://masterweb.jpl.nasa.gov



IV. Ground Networks

IV.1 FLUXNET
IV.2 NEXRAD

IV.1

FLUXNET

FLUXNET is a global network of micrometeorological flux measurement sites where the exchanges of carbon dioxide, water vapor, and energy between the biosphere and atmosphere are measured. At present over 150 sites on 5 continents are operating on a long-term and continuous basis. The sites' latitudinal distribution ranges from 70 degrees north to 30 degrees south.

MEASUREMENTS:

- CO2 flux
- Evaporation and energy absorption (used in Terra validation)

NETWORK INSTRUMENTS:

- Three-dimensional sonic anemometer
- Fast-responding sensor

VITAL FACTS:

- Number of Stations: 150+
- Start of Program: 1995

OWNER:

- U.S., NASA

http://www.daac.ornl.gov/FLUXNET/fluxnet.html

IV.2 NEXRAD
(Next Generation Weather Radar)

NEXRAD is a system of radars set up to replace 128 aging radars across the country. The goal is to deploy and bring online new Doppler-type radars throughout the country and in parts of the Caribbean. NEXRAD provides a suite of unaltered products that are determined by the radar unit's volume coverage pattern (VCP). Depending on the type of weather in the area of the unit, the operator at the site will put the radar into one of the following three VCP modes: Clear Air Mode, Precipitation Mode, or Severe Weather Mode.

MEASUREMENTS:
- Reflectivity, velocity, and spectrum width of atmospheric disturbance

NETWORK INSTRUMENTS:
- Doppler Radar

VITAL FACTS:
- Number of Stations: 158
- Start of Program: 1988

OWNER:
- U.S., NOAA

http://www.roc.noaa.gov/

V. Current Missions

V.1 Aqua
V.2 Landsat 7
V.3 NOAA-L POES (Polar-orbiting Operational Environmental Satellite)
V.4 RADARSAT-1
V.5 Terra
V.6 TOMS-EP (Total Ozone Mapping Spectrometer-Earth Probe)
V.7 TRMM (Tropical Rainfall Measuring Mission)

V.1

Aqua

Aqua gathers information about water in the Earth's system. Aqua collects data on the Earth's water cycle, including evaporation from the oceans, water vapor in the atmosphere, clouds, precipitation, soil moisture, sea ice, land ice, and snow cover on land and ice. The six sensors onboard Aqua provide regional to global land cover, land cover change, and atmospheric measurements, thus making contributions to the monitoring of terrestrial and marine ecosystem dynamics and their relationships to changes in the Earth system.

MEASUREMENTS:

- Sea surface and atmospheric temperature
- Cloud properties and water vapor profile
- Vegetation dynamics
- Soil moisture
- Snow cover and sea ice
- Radiative energy flux; radiation balance
- Ocean productivity

VITAL FACTS:

- Orbit Type: Sun-synchronous
- Altitude: 705 km
- Inclination: 98.2°
- Launch Date: May 4, 2002
- Design Life: 6 years

MISSION SENSORS:

- AMSR-E (Advanced Microwave Scanning Radiometer-EOS)
- AIRS (Atmospheric Infrared Sounder)
- AMSU-A (Advanced Microwave Sounding Unit-A)
- CERES (Clouds and the Earth's Radiant Energy System)
- HSB (Humidity Sounder for Brazil)
- MODIS (Moderate Resolution Imaging Spectroradiometer)

OWNER:

- U.S., NASA

http://aqua.nasa.gov

V.2

Landsat 7

Landsat 7 provides well-calibrated, multispectral, moderate-resolution, substantially cloud-free, sunlit digital images of the Earth's continental and coastal areas, with global coverage on a seasonal basis, using the Enhanced Thematic Mapper Plus (ETM+) sensor. This sensor provides information on the Earth's surface in the visible, near, middle, and thermal infrared regions of the electromagnetic spectrum. Landsat 7 was designed to acquire data about the Earth on a systematic, repetitive basis, and collects and transmits up to 532 scenes per day.

MEASUREMENTS:

- Land cover and land use change
- Vegetation dynamics

VITAL FACTS:

- Orbit Type: Sun-synchronous
- Altitude: 705 km
- Inclination: 98.2°
- Launch Date: April 15, 1999
- Design Life: 5 years

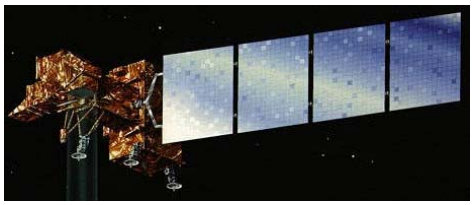
MISSION SENSOR:

- ETM+ (Enhanced Thematic Mapper Plus)

OWNER:

- U.S., NASA
- U.S., USGS

http://landsat7.usgs.gov/
http://landsat.gsfc.nasa.gov/



V.3

NOAA-L POES

NOAA-L POES (National Oceanic and Atmospheric Administration Polar-orbiting Operational Environmental Satellites) provides global coverage of numerous atmospheric and surface parameters for weather forecasting and meteorological research, as well as space environment monitors and an aircraft and maritime emergency beacon system.

MEASUREMENTS:

- Global ozone concentration and vertical distribution of atmospheric ozone
- Spectral solar irradiance
- Global atmospheric temperature and humidity profiles
- Vertical water vapor profiles

VITAL FACTS:

- Orbit Type: Sun-synchronous
- Altitude: 833 km
- Inclination: 98.8°
- Launch Date: September 21, 2000
- Design Life: 2 years

MISSION SENSORS:

- AVHRR (Advanced Very High Resolution Radiometer)
- HIRS (High-resolution Infrared Radiometer Sounder)
- AMSU-A (Advanced Microwave Sounding Unit-A)
- AMSU-B (Advanced Microwave Sounding Unit-B)
- MHS (Microwave Humidity Sounder)
- SBUV (Solar Backscatter Ultraviolet Radiometer)
- SEM (Space Environment Monitor)

OWNER:

- U.S., NOAA

http://poes.gsfc.nasa.gov

V.4

RADARSAT-1

RADARSAT-1 is a satellite developed to monitor environmental change and to support resource sustainability. RADARSAT uses Synthetic Aperture Radar (SAR), an active microwave sensor, allowing 24-hour data collection independent of weather conditions and illumination. RADARSAT-1 provides useful data in the fields of agriculture, cartography, hydrology, forestry, oceanography, ice studies, and coastal monitoring.

MEASUREMENTS:

- Soil moisture
- Land cover/usage
- Coastline changes

VITAL FACTS:

- Orbit Type: Sun-synchronous
- Altitude: 798 km
- Inclination: 98.6°
- Launch Date: November 4, 1995
- Design Life: 5 years

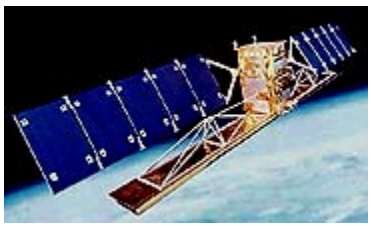
MISSION SENSOR:

- SAR (Synthetic Aperture Radar)

OWNER:

- Canada, CSA

http://www.space.gc.ca/csa_sectors/earth_environment/radarsat/default.asp



V.5

Terra

The instruments onboard Terra collect global datasets on the Earth's atmosphere, land, and oceans, as well as their interactions with solar radiation and with one another. Terra descends across the equator at approximately 10:30 a.m. every day. Terra's morning observations and Aqua's afternoon observations yield important insight into the diurnal variability or the daily cycling of key scientific parameters.

MEASUREMENTS:

- Surface bidirectional reflectance distribution function (BRDF)
- Carbon monoxide and methane in the troposphere
- High-resolution images and maps of land surface temperature
- Earth's radiation budget and atmospheric radiation
- Sea surface temperature and ocean productivity

VITAL FACTS:

- Orbit Type: Sun-synchronous
- Altitude: 720 km
- Inclination: 98.2°
- Launch Date: December 18, 1999
- Design Life: 5 years

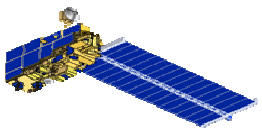
MISSION SENSORS:

- CERES (Clouds and the Earth's Radiant Energy System)
- MISR (Multi-angle Imaging Spectro-Radiometer)
- MODIS (Moderate Resolution Imaging Spectroradiometer)
- MOPITT (Measurements of Pollution in the Troposphere)
- ASTER (Advanced Spaceborne Thermal Emission and Reflection)

OWNERS:

- U.S., NASA
- U.S., JPL

http://terra.nasa.gov



V.6 TOMS-EP
(Total Ozone Mapping Spectrometer–Earth Probe)

The Total Ozone Mapping Spectrometer–Earth Probe (TOMS–EP) provides high-resolution measurements for the study of UV-absorbing aerosols in the troposphere. TOMS–EP provides daily long-term observations of the global distribution of the Earth's ozone layer and measurements of sulphur dioxide released in volcanic eruptions.

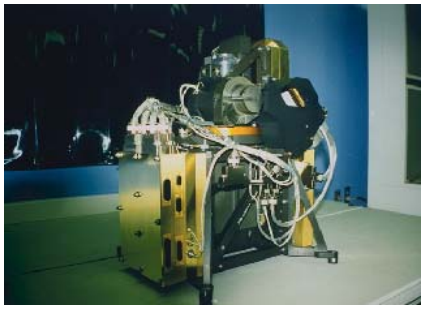
MEASUREMENTS:
- Aerosol index
- Reflectivity
- Total UV radiation exposure
- Total column ozone

VITAL FACTS:
- Orbit Type: Sun-synchronous
- Altitude: 740 km
- Inclination: 98.385°
- Launch Date: July 2, 1996
- Design Life: 2 years

MISSION SENSORS:
- TOMS (Total Ozone Mapping Spectrometer)

OWNER:
- U.S., NASA

http://toms.gsfc.nasa.gov



V.7 TRMM
(Tropical Rainfall Measuring Mission)

The Tropical Rainfall Measuring Mission (TRMM) is designed to measure quantitatively precipitation from space. TRMM monitors tropical and subtropical rainfall for the study of rainfall variability and the associated release of energy, which helps to power the Earth's atmospheric circulation that affects both weather and climate around the globe.

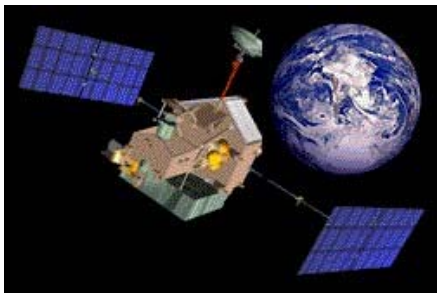
MEASUREMENTS:
- Earth's radiation budget and atmospheric radiation
- 3-D rainfall distribution over land and oceans
- Cloud radiation, cloud distribution and height, and rain estimates from brightness temperature
- Lightning distribution and variability over the Earth

VITAL FACTS:
- Orbit Type: Low-inclination orbit
- Altitude: 402 km
- Inclination: 35°
- Launch Date: November 27, 1997
- Design Life: 3 years

MISSION SENSORS:
- CERES (Clouds and the Earth's Radiant Energy System)
- LIS (Lightning Imaging Sensor)
- TMI (TRMM Microwave Imager)
- PR (Precipitation Radar)
- VIRS (Visible and Infrared Scanner)

OWNER:
- U.S., NASA

http://trmm.gsfc.nasa.gov



VI. Future Missions

VI.1 MetOp (Meteorological Operations)
VI.2 RADARSAT-2
VI.3 SMOS (Soil Moisture and Ocean Salinity)

VI.1 MetOp
(Meteorological Operational)

The MetOp satellite will be a polar-orbiting satellite dedicated to operational meteorology. It will replace the meteorological satellites currently being used in weather forecasting. MetOP will provide data that will be used to monitor the Earth's climate and to improve weather forecasting. MetOp will also contribute to the global surveillance of the air, land, sea, and ice environment. MetOp is scheduled for launch in early 2007.

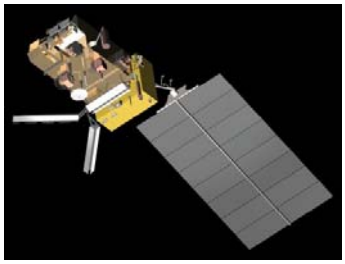
MEASUREMENTS:
- Total column amounts of stratospheric and tropospheric profiles of ozone

VITAL FACTS:
- Orbit Type: Sun-synchronous
- Altitude: 835 km
- Inclination: 98.7°
- Launch Date: 2007
- Design Life: 5 years

MISSION SENSORS:
- ASCAT (Advanced Scatterometer)
- GOME-2 (Global Ozone Monitoring Experiment 2)
- IASI (Infrared Atmospheric Sounder Interferometer)
- MHS (Microwave Humidity Sounder)
- HIRS/4 (High Resolution Infrared Sounder)
- AVHRR/3 (Advanced Very High Resolution Radiometer)

OWNER:
- Europe, ESA

http://www.esa.int/export/esaME/index.html



VI.2

RADARSAT-2

RADARSAT-2 will carry the world's most advanced Synthetic Aperture Radar (SAR), capable of delivering high-resolution, multi-polarized imagery to reception sites around the world. RADARSAT-2 will benefit such diverse applications as agriculture, mapping, coastal and ocean processes, forestry, natural resources, environmental monitoring, and natural disaster mitigation and response. RADARSAT-2 is scheduled for launch in early 2004.

MEASUREMENTS:

- Soil moisture
- Land cover/usage
- Coastline changes

VITAL FACTS:

- Orbit Type: Sun-synchronous
- Altitude: 798 km
- Inclination: 98.6°
- Launch Date: 2004
- Design Life: 7 years

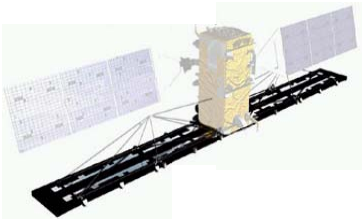
MISSION SENSOR:

- C-band SAR (Synthetic Aperture Radar)

OWNER:

- Canada, CSA

http://www.space.gc.ca/csa_sectors/earth_environment/radarsat/default.asp



VI.3 SMOS
(Soil Moisture and Ocean Salinity)

The Soil Moisture and Ocean Salinity (SMOS) mission's objective is to provide global observations of two crucial variables for modeling the weather and climate: soil moisture and ocean salinity. The SMOS mission will also monitor vegetation water content, snow cover, and ice structure. SMOS is scheduled for launch in 2006.

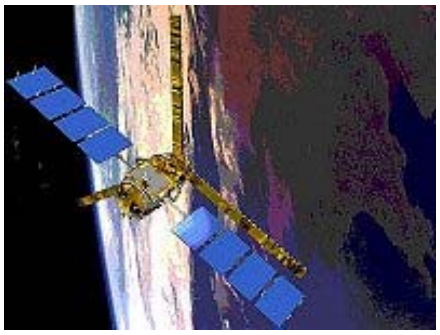
MEASUREMENTS:
- Sea surface salinity and soil moisture in support of climate, meteorology, hydrology, and oceanography applications

VITAL FACTS:
- Orbit Type: Sun-synchronous
- Altitude: 755 km
- Launch Date: January 2006
- Design Life: 3 years

MISSION SENSOR:
- MIRAS (Microwave Imaging Radiometer using Aperture Synthesis) – passive L-band 2D-interferometer

OWNER:
- Europe, ESA

http://www.esa.int/export/esaLP/smos.html



Acronym List

BRDF	Bidirectional Reflectance Distribution Function
CSA	Canadian Space Agency
CNES	Centre National d'Etudes Spatiales
EMR	Electromagnetic Radiation
EMS	Electromagnetic Spectrum
EOS	Earth Observing System
ESE	Earth Science Enterprise
ESA	European Space Agency
EU	European Union
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
GPS	Global Positioning System
IFOV	Instantaneous Field Of View
IR	Infrared
JPL	Jet Propulsion Laboratory
Lidar	Light Detection and Ranging
METI	Ministry of Economy, Trade and Industry
NASA	National Aeronautics and Space Administration
NASDA	National Association of State Departments of Agriculture
NOAA	National Oceanic and Atmospheric Administration
NIR	Near Infrared
Radar	Radio Detection and Ranging
SWIR	Short-wave Infrared
SAR	Synthetic Aperture Radar
TBD	To Be Determined
TIR	Thermal Infrared
UV	Ultraviolet
USGS	United States Geological Survey
VIS	Visible
VNIR	Visible Near-infrared

Glossary

Absorption band: the wavelength interval within which electromagnetic radiation is absorbed by the atmosphere or by other substances.
Active sensor: a sensor that generates its own electromagnetic energy, usually within the microwave wavebands.
Adjacency: the atmospheric scattering of radiance that originates outside of the sensor's field of view.
Albedo: the ratio of the radiation reflected from an object to the total amount incident upon it, for a particular portion of the spectrum.
Along-track scanner (pushbroom): a scanner with a linear array of detectors oriented normal to flight path. The instantaneous field of view of each detector sweeps a path parallel with the flight direction.
Anemometer: an instrument for measuring and indicating the force or speed of the wind.
Aperture: (1) the opening in a photographic lens that admits the light; (2) the diameter of the stop in an optical system that determines the diameter of the bundle of rays traversing the instrument; (3) the diameter of the objective lens or mirror of a telescope.
Atmosphere: the layer of gases that surrounds some planets.
Atmospheric upwelled radiance: the radiance from the atmosphere scattered upward into the sensor's line of site along the sensor-target path.
Azimuth: the linear distance or image scale in the along-track (pushbroom) direction.
Background object radiance: the photons incident on the target due to radiant emission from an object near the target.
Backscatter: in radar, the portion of the microwave energy scattered by the terrain surface directly back toward the antenna.
Band: (1) a selection of wavelengths; (2) a frequency band; (3) an absorption band; (4) a range of radar frequencies, such as X-band, Q-band, etc.
Biosphere: the part of the Earth on which life can exist.
Blackbody: an ideal substance that absorbs all the radiant energy incident on it and emits radiant energy at the maximum possible rate per unit area at each wavelength for any given temperature. No actual substance is a true blackbody, although some substances approach its properties.
Calibration: the act or process of comparing certain specific measurements in an instrument with a standard.
Cross-track scanner (whiskbroom): a scanner in which a faceted mirror rotates about a horizontal axis to sweep the detector instantaneous field of view in a series of parallel scan lines oriented normal to the flight direction.
Design life: the minimal expected functional longevity of a satellite mission or sensor.
Doppler: the apparent change of frequency of sound waves or electromagnetic waves, varying with the relative velocity of the source and the observer. Shift in frequency caused by relative motion along the line of sight between the sensor and the observed scene.
Downwelled radiation: the photons incident on the target due to scattering from the atmosphere.

Emissivity: the ratio of radiant flux from an object to that from a blackbody at the same kinetic temperature and emissivity.
Flux: the rate of flow of fluid particles, energy, and radiation through a surface perpendicular to the direction of transmission.
Frequency: (1) the number of oscillations per unit time or number of wavelengths that pass a point per unit time; (2) the rate of oscillation of a wave.
Geostationary orbit: an orbit at roughly 41,000 km in the direction of the Earth's rotation, which matches speed so that a satellite remains over a fixed point on the Earth's surface.
Geosynchronous orbit: an orbit that revolves with the Earth's revolution. Satellites placed in a geosynchronous orbit remain in a constant relative position to the Earth.
Hydrosphere: the aqueous envelope of the Earth including bodies of water and aqueous vapor in the atmosphere
Hyperspectral sensor: a sensor that measures radiation in very narrow bandwidths (typically, around 0.02 μm) from which a quasi-continuous spectral curve can be produced.
Incidence angle: in radar, the angle formed between an imaginary line normal to the surface and another connecting the antenna and the target.
Infrared: pertaining to EMR in the 0.8 to 100 μm region of the spectrum.
In situ: a ground-based device or platform.
Interferometer: a device, such as imaging radar, that uses two different paths for imaging and deduces information from the coherent interference between the two signals.
Ionosphere: the part of the Earth's atmosphere in which ionization of atmospheric gases affects the propagation of radio waves.
Irradiance: the density of the radiant flux that is incident on a surface per unit of wavelength.
Lidar: light intensity detection and ranging. Lasers are used to stimulate fluorescence in various compounds (differential absorption lidar) and to measure distances to reflecting surfaces (ranging).
Lithosphere: the outermost part of the solid Earth, usually considered to be about 50 miles (80 kilometers) in thickness.
Microwave: the region of the electromagnetic spectrum in the wavelength range of 0.1 to 30 cm.
Multi-reflected radiance: the scattering of radiance onto the target due to objects outside of the sensor's field of view.
Multispectral sensor: a sensor that detects energy in two or more bands of the electromagnetic spectrum.
Nadir: a point on the ground directly in line with the remote sensing system and the center of the Earth.
Occultation: the natural or artificial eclipsing of a light source.
Orbital platform: a space-based system capable of carrying various payloads above the Earth's surface.
Ozone: a triatomic, very reactive form of oxygen that is formed naturally in the atmosphere by a photochemical reaction. Ozone is a major air pollutant in the lower atmosphere but a beneficial component of the upper atmosphere.
Panchromatic film: a black and white film that is sensitive to all visible wavelengths.

Passive sensor: a sensing system that detects or measures radiation emitted or reflected by the target.
Polar orbit: an orbit that passes close to the poles, thereby enabling a satellite to pass over most of the surface, except the immediate vicinity of the poles themselves.
Polarimeter: an instrument that can quantify the amount of polarization of light or the proportion of polarized light in a partially polarized ray.
Polarization: the direction of orientation in which the electrical field vector of electromagnetic radiation vibrates.
Pushbroom (along-track): a scanner with a linear array of detectors oriented normal to flight path. The instantaneous field of view of each detector sweeps a path parallel with the flight direction.
Radar: radio detection and ranging. Radar is an active form of remote sensing that operates in the microwave and radio wavelength regions (10^5-10^9 um)
Radiance: a measure of the energy radiated by the object together with the frequency distribution of that radiation.
Radiant flux: the rate of flow of fluid particles, energy, and radiation through a surface perpendicular to the direction of transmission.
Radiation: the emission and propagation of waves transmitting energy through space or through some medium.
Radiometer: a device for quantitatively measuring radiant energy, especially thermal radiation.
Radiometric resolution: the ability of a sensor to detect very slight energy differences.
Reflectance: the ratio of the radiant energy reflected by a body to the energy incident on it. Spectral reflectance is the reflectance measured within a specific wavelength interval.
Repeat time: the time for any point in a sensor swath to pass over the same point on the surface of the Earth (temporal resolution).
Scattering: the multiple reflections of electromagnetic waves by particles in the atmosphere or from surfaces.
Scatterometer: a nonimaging radar device that quantitatively records backscatter of terrain as a function of incidence angle.
Scintillation: (1) the variation in intensity of a light beam as it travels through the atmosphere; (2) in lasers, the rapid changes in the levels of irradiance in the cross section of a laser beam.
Self-emitted radiance: the radiance emitted from an object due to its temperature.
Sensor: a device that receives electromagnetic radiation and converts it into a signal that can be recorded and displayed as either numerical data or an image.
Skylight: the diffuse light from the sky, scattered by air molecules, as distinguished from the direct radiation from the sun.
Sonar: sound navigation ranging. Sonar is an active form of remote sensing that employs sonic energy to image the seafloor.
Sounder: an instrument that measures atmospheric profiles (e.g., temperature, pressure, moisture, etc.).
Spatial resolution: a measure of the smallest angular or linear separation between two objects.

Spectral resolution: the number and dimension of bands (or wavelengths) of the electromagnetic spectrum that a sensor records. The higher the number of bands, the greater the sensor's ability to distinguish between objects.
Spectrum: the continuous sequence of electromagnetic energy arranged according to wavelength or frequency.
Spectrometer: a device that measures the intensity of radiation that is absorbed or reflected by a material as a function of wavelength.
Spectroradiometer: an instrument for determining the radiant energy distribution in a spectrum, combining the functions of a spectrometer with those of a radiometer.
Suborbital platform: an in-atmosphere airborne vehicle intended for short duration missions above the Earth's surface.
Sun-synchronous: an orbit in which the satellite crosses the equator at the same local sun time every day.
Swath width: the overall plane angle or linear ground distance covered by a scanner in the across-track dimension.
Synthetic-aperture radar (SAR): a radar system in which high azimuth resolution is achieved by storing and processing data on the Doppler shift of multiple return pulses in such a way as to give the effect of a much longer antenna.
Temporal resolution: also known as **repeat time**; the frequency with which a sensor passes over the same area.
Thematic data: a representation on a plane surface, at an established scale, of the physical features (natural, artificial or both) of a part or the whole of the Earth's surface, or of any desired surface or subsurface data, by means of signs or symbols.
Transmissivity: the property of a material that determines the amount of energy that can pass through the material.
Transmittance: the fraction of radiant energy that having entered a layer of absorbing matter reaches its farther boundary.
Upwelled radiance: the radiance from the sun scattered upward into the sensor's line of site along the sensor-target path.
UV: the ultraviolet region of the electromagnetic spectrum ranging in wavelengths from 0.3 to 0.4 μm.
Wavelength: the distance between successive wave crests or other equivalent points in a harmonic wave.
Whiskbroom (cross-track): a scanner in which a faceted mirror rotates about a horizontal axis to sweep the detector instantaneous field of view in a series of parallel scan lines oriented normal to the flight direction.

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